

Plan for Protection of Fish, Wildlife, and other Legal Users of water during Stage 2 Joint Point of Diversion of CVP water at Banks Pumping Plant

Introduction

Water Rights Decision 1641 (D1641) authorizes the diversion of water by the Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) through each other's Delta pumping plants if certain conditions are met. This authorized change of the point of diversion for the projects is known as Joint Points of Diversion (JPOD). D1641 authorizes three stages of JPOD, each carrying successively more restrictive conditions for use. For Stage 2 JPOD uses, Reclamation and DWR are required to develop, in consultation with the California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service (FWS) and NOAA Fisheries (NMFS), an operations plan to protect fish and wildlife and other legal users of water.

This document describes the essential elements of an operations plan for JPOD limited to the months of July, August, September and October of 2004. The specific intent of this plan is to avoid or minimize adverse fish and wildlife impacts of Stage 2 JPOD during the four months specified above. This plan is designed to accomplish that objective under the current conditions, operations requirements, and regulatory environment. The plan consists of a framework with attachments providing detailed information and may only be changed or amended after written approval from the Executive Director of the State Water Resources Control Board (SWRCB).

This plan relies on an existing network of monitoring, data collection, and processing, and makes use of an effective process of coordination, evaluation, and decision-making which has evolved subsequent to the adoption of D-1641. The CalFed Operations Group Data Assessment Team (DAT), an agency and stakeholder group, normally holds weekly teleconferences between October and June. These teleconferences are normally suspended during the July through September period when fishery concerns are very low. For these months, in lieu of regular DAT coordination, the weekly B2IT meeting (the B2 Interagency Team, which was established to manage water dedicated under CVPIA 3406 b(2)) will serve to inform Agency representatives and assess ongoing monitoring during JPOD operations. When required, the B2IT will also serve to develop actions in response to monitoring, triggers, or other thresholds. B2IT members may also be required to meet or teleconference on a timely basis to provide a response when called for by this plan. Actions developed by the B2IT will be conveyed to other agencies and stakeholders through DAT teleconference calls (as needed), which will be typically convened within 24 hours. Unresolved issues will be elevated to WOMT (Agency management representatives of the Water Operations Management Team). If resolution cannot be reached, the Executive Director of the State Water Resources Control Board (SWRCB) will be notified and the Stage 2 increment of JPOD will cease until agreement on how to proceed is reached.

(a) Specific measures to avoid or minimize the effects of export operations at Banks Pumping Plant on entrainment and through-Delta survival of Chinook salmon. Monitoring of environmental conditions and fish abundance at upstream locations, as appropriate, to determine vulnerability of Chinook salmon to entrainment at Banks

Pumping Plant. Monitoring of entrainment at Banks Pumping Plant, including frequency and method of data collection.

This plan specifically covers the months of July, August, September and October 2004. July-September was selected to limit JPOD operations to periods of historically low vulnerability of Chinook salmon in the Delta, and no significant impacts to Chinook salmon are expected. Additional protective criteria are applied in the month of October, since there may be concerns for salmonids at that time depending on river conditions and hydrology. These criteria are outlined as required in subsequent paragraphs.

Many of the upstream salmon monitoring projects cease to operate during the July through September period because too few salmon have been caught in the past to justify the effort. The B2IT will monitor results from those sampling programs which continue through the summer for indications of older juvenile salmon movement. These programs typically include the lower Sacramento River beach seine and trawl, as well as beach seining in the north, central, and west Delta. If the Sacramento Catch Index of older juvenile salmon is greater than 3 (see Salmon Decision Tree, attached), the B2IT will evaluate the information, identify and implement measures to avoid or minimize any impacts of JPOD on salmon survival and elevate the issue to WOMET for further discussion if no agreement on implementing mitigation measures can be reached.

During the month of October the full suite of juvenile salmon sampling efforts will resume, and the upstream monitoring criteria in the Salmon Decision Tree will be followed (i.e. if the Sacramento Catch Index exceeds 3 the WOMET will consider closing the Delta Cross-channel gates).

Continuous monitoring of entrainment (including frequency and methods) at Banks Pumping Plant will be conducted per ongoing procedures established by the 1993 NMFS Winter Run Biological Opinion, NMFS Spring Run/Steelhead Biological Opinion, and the Four Pumps Agreement, Appendix A (Applicable sections of these documents will be attached). The response to salmon entrainment monitoring is described below.

(b) Minimum survival levels for Chinook salmon, which shall be used to trigger consultation with fishery agencies regarding data evaluation and decision making to minimize or avoid the impact of pumping at Banks Pumping Plant. Identify the consultation process that will be used if triggers are hit and identify the parties who will consult, how they will be notified, and a time schedule for decision making.

During the July – September time frame, salmon entrainment is expected to be negligible. The fish agencies do not foresee any circumstances that would require action to modify or terminate JPOD to protect Chinook salmon. No SWP/CVP take limits for salmon exist for this period. However the USFWS, NMFS, and DFG will consider the loss of 5 older juvenile salmon per thousand acre-feet (TAF) of exported water as a trigger for consideration of action to avoid or minimize impacts of JPOD on salmon survival. The term “older juvenile” Chinook is defined for this purpose as salmon larger than the minimum size defining the winter run size range. This designation will include any late-fall run, yearling spring run, and yearling fall-run Chinook that may be present, as well as the winter run Chinook.

In October, the Salmon Decision Tree criteria will take effect, and the salvage criteria of 8 older juvenile salmon per TAF will serve as a protective trigger.

In the event that triggers are hit, the responsible parties (USBR, DWR, DFG, USFWS, & NOAA Fisheries/NMFS) will confer via a B2IT meeting within 24 hours. A subsequent DAT call will be used to inform and exchange information between the responsible parties and with stakeholders. Notification of these DAT calls shall be via phone, FAX or email. Responsible parties shall have a maximum of an additional 24 hours to reach decisions on mitigation measures, or on continuation or cessation of JPOD.

If the triggering level is reached and no action to reduce the take of Chinook salmon can be developed via DAT and WOMT process, JPOD will immediately cease until the daily loss density falls below the triggering level.

(c) Specific measures at Trinity, Shasta, or Folsom reservoirs to avoid or minimize adverse effects to Chinook salmon if upstream or Delta monitoring indicates that such impacts are occurring.

During JPOD operations, the existing flow, temperature, and carryover storage requirements on the Trinity, Sacramento, and American Rivers remain in force. During the July-October time frame, no further upstream actions are anticipated except as may be called for in other portions of this plan.

In the lower Sacramento and Delta, criteria defined by the Salmon Decision Tree will be followed if fish monitoring indicates that significant numbers of juvenile salmon are present in the lower Sacramento River or in the southern Delta. If the "Decision Tree" criteria are approached or exceeded, the B2IT or the DAT will be convened within 24 hours to discuss appropriate measures to avoid or minimize impacts on Chinook salmon.

Delta cross-channel gate closures will be considered if either the Knights Landing or Sacramento catch index of older juvenile Chinook exceeds 3. This may be outside the closure periods specified in D-1641, and fishery protection actions may necessitate a short-term closure.

Increasing Delta outflow or curtailing JPOD exports will occur if the combined SWP/CVP loss of older juvenile Chinook exceeds 5 fish/TAF during July-September period, or exceeds 8 fish/TAF in October.

(d) Operating criteria to insure that JPOD does not significantly impact aquatic resources in upstream areas due to changes in flow, water temperature, and reservoir water levels.

As noted in (c), during JPOD operations the existing flow, temperature, and carryover storage requirements on the Trinity, Sacramento, and American Rivers will remain in force.

On the Sacramento River the Winter-run Chinook Biological Opinion requires that temperatures be maintained at $\leq 56^{\circ}\text{F}$ between April 15 and September 30, and $\leq 60^{\circ}\text{F}$ from October 1 through October 31 at various compliance points. In addition, end of September storage in Shasta Reservoir must not go below 1.9 MAF.

On the lower American River the Spring-run Chinook and Steelhead Biological Opinion states that "Reclamation shall, to the extent possible, control water temperatures in the lower river between Nimbus Dam and the Watt Avenue Bridge (RM 9.4) from June 1 through November 30, to a daily average temperature of less than or equal to 65°F to protect rearing juvenile steelhead from thermal stress and from warm water predator species."

Due to the relatively low projected carryover storage and the very limited cold water pool at Folsom Reservoir, the primary source of water for JPOD will be Shasta Reservoir. Releases from Keswick Reservoir will be adjusted to support the changes in export pumping due to the increment of JPOD pumping at Banks, with travel time considered. Nevertheless, it should be noted that changes in accretions/depletions, temperature operations, and applicable regulatory standards over the period of JPOD, will probably require Shasta release changes that do not necessarily directly correspond to JPOD pumping.

If system modeling, temperature modeling, or real-time monitoring indicates that JPOD operations will have a significant negative affect on any of the above criteria, the B2IT will be convened within 24 hours to evaluate whether JPOD exports should be curtailed.

(e) Specific measures to protect other legal users of water.

At least 30 days prior to beginning stage 2 JPOD operations, the potential for such operation will be discussed at the regular monthly CALFED OPS group meeting.

Prior to beginning JPOD, agency points of contact will be provided to B2IT and the Operations and Fishery Forum (OFF), and placed on the USBR CVO Web page.

An initial response to an allegation of harm from a legal user of water will be provided in writing within 72 hours by USBR and/or DWR staff. The USBR and DWR will attempt to verify that harm has resulted or is resulting specifically from JPOD operations, and if so, provide mitigation to the extent of the incremental impact due to JPOD. If such mitigation measures cannot be provided within a reasonable time frame, JPOD operations will cease. Allegations of harm will be forwarded to the SWRCB. If allegations of harm are contested by the USBR and/or DWR, or if effective incremental mitigation cannot be provided in a timely manner, the issue shall be immediately forwarded to the Executive Director of the SWRCB for resolution.

(f) Specific measures to mitigate significant effects on recreational and cultural resources at affected reservoirs.

Recreational impacts shall be deemed to occur only when reservoirs which provide water for export under JPOD meet the both of the following:

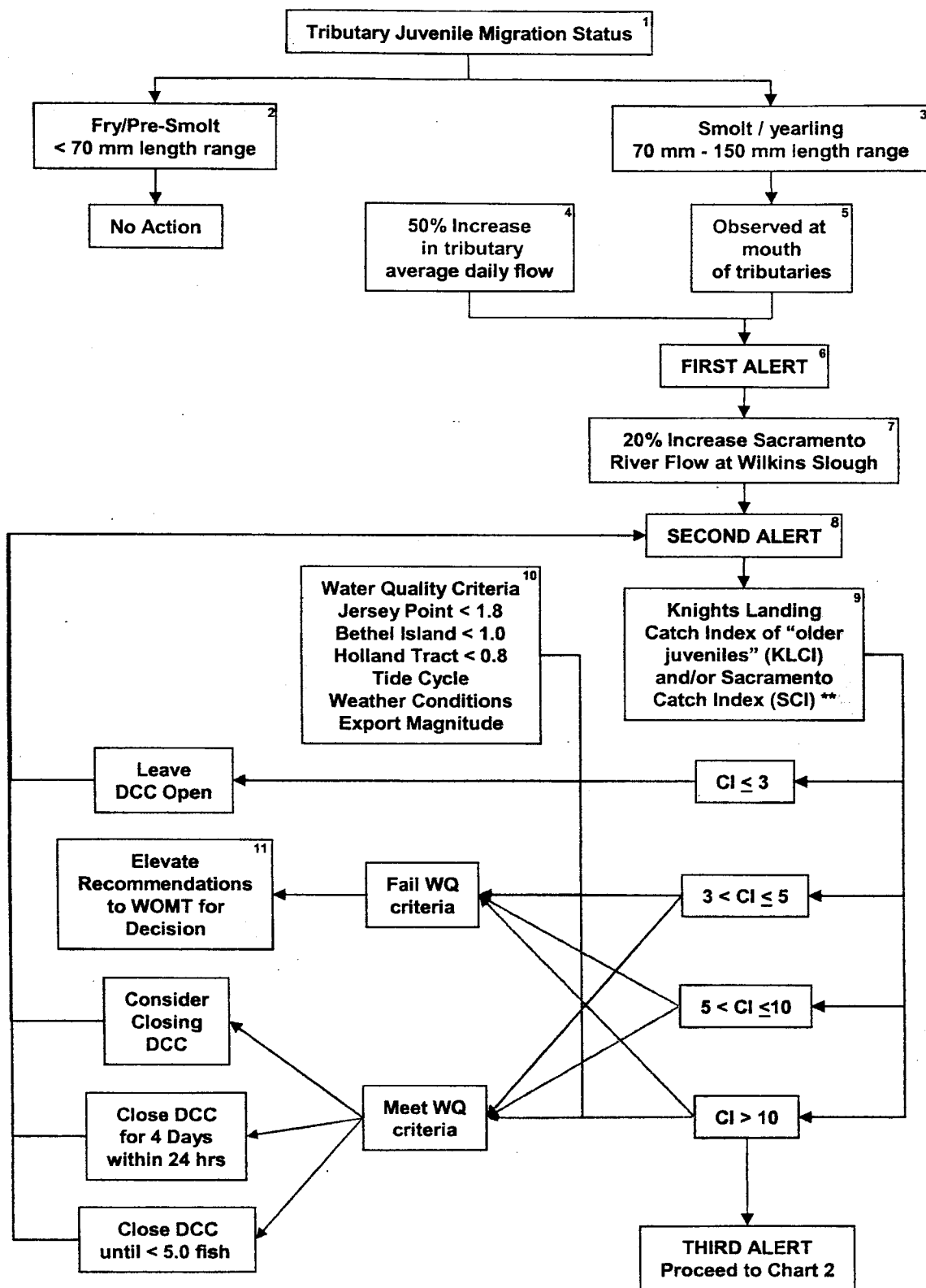
1. Actual operations with JPOD are forecasted to draw affected reservoirs below the end of water year (Sept 30) storage which would have occurred under D-1485 with Federal replacement pumping, and,
2. Actual operations with JPOD are forecasted to draw affected reservoirs below the useable elevation of the lowest boating access prior to Labor Day weekend.

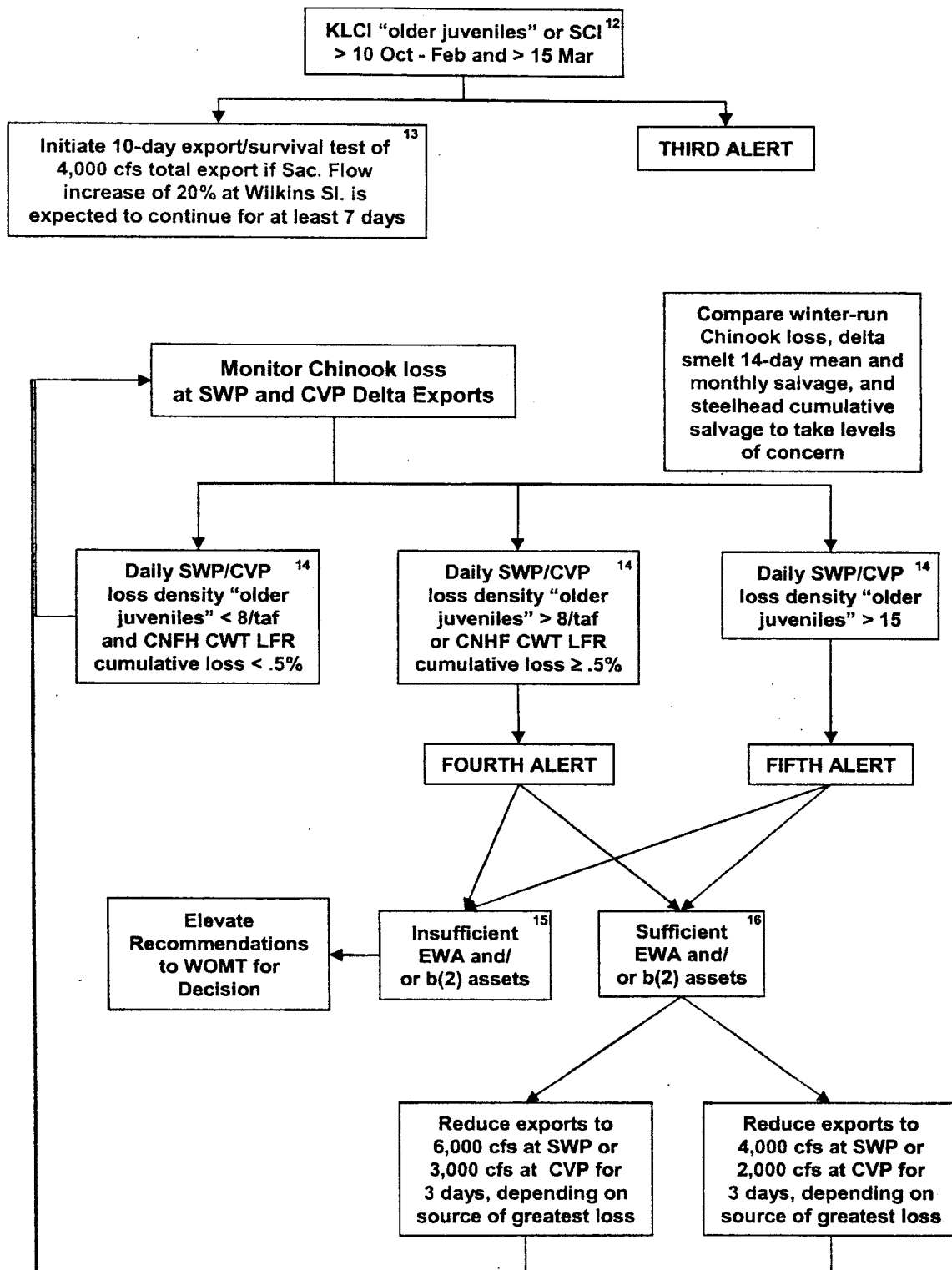
Mitigation for significant recreational impacts may consist of actions such as installation of temporary boat launching facilities, or temporary access points to the reservoir. In the event that DWR or Reclamation is unable to implement mitigation actions, JPOD operations will not occur.

Cultural resources have been evaluated and preserved during the pre-construction period and/or in the 1976-1977 and 1987-1992 periods when reservoirs were drawn down to historic minimums. JPOD will not occur when it would cause reservoirs to be drawn to or below historic minimum elevations. Nevertheless, the USBR shall endeavor to protect and catalog any significant, newly identified cultural resources which may be discovered during JPOD operations. In addition, the USBR Regional Archaeologist or other designated staff will be provided with a copy of expected water surface elevations for affected reservoirs during the period of JPOD in order to ensure that previously identified cultural resources can be protected or further investigated as required.

An initial response to allegations of impacts to recreational and/or cultural resources shall be provided by the USBR or DWR in writing within 72 hours. Unresolved disputes shall be forwarded to the Executive Director of the SWRCB for resolution.

SALMON "DECISION TREE"





2001/2002 Chinook decision process October through March (Chart 2 of 2).

Annotation - 2003 Salmon Decision Process

- 1 - Mill, Deer and Butte creeks are the most important populations of spring Chinook today (DFG. June 1998. Report to the Fish and Game Commission: A Status Review of the Spring-run Chinook Salmon in the Sacramento River Drainage. Candidate Species Status Report 98-01). DFG operates rotary screw traps near the mouths of these three tributaries to monitor the emigration of spring run yearlings, and later, spring run and fall run fry.
- 2 - Juvenile Chinook in the spring Chinook tributaries less than 70 mm between October and April are fall run or spring run fry or pre-smolts (Figure 1) and not the focus of the Salmon Decision Process actions.
- 3 - Juvenile Chinook in the spring run tributaries greater than 70 mm between October and April are spring run yearlings (Figure 1) and the focus of the Salmon Decision Process actions.
- 4 - Yearling spring run are difficult to trap, due to their low numbers and strong swimming ability, therefore a significant increase in flow is a surrogate for trapping yearling spring run. The first significant flow in October is associated with the beginning of emigration (Figures 2 - 4).
- 5 - Yearling spring run at the mouths of the spring run tributaries are in the Sacramento River and are susceptible to Delta mortality factors associated with the Delta Cross Channel (DCC) and SWP/CVP export operations.
- 6 - The "First Alert" is the early warning criteria for closing the DCC..
- 7 - Wilkins Slough is the flow gage near Knights Landing and about 35 miles upstream of the Delta. A significant flow increase at Wilkins Slough is associated with juvenile emigration past Knights Landing (Figure 5).
- 8 - The "Second Alert" is the warning criteria for closing the DCC. The First and Second alerts are important warning criteria because information and data dissemination, and agency coordination for an action can take several days.
- 9 - Catches Indexes at Knights Landing and/or Sacramento are the criteria upon which the first action is based; closing the Delta Cross Channel Gates (DCC) (Figures 6 and 7). The raw catches are standardized to one day of effort, but do not include catch efficiency. Depending on the catch magnitude, there are several options for closing the DCC, ranging from not closing them, and continuing to monitor catch at KL and/or Sac, to closing them until the catch index decreases to 5 fish per day.

- 10 - Closing the DCC for fish protection can adversely impact Delta salinity from November through January. Without Sacramento River freshwater flowing through the DCC and into the central Delta to the bay, saline ocean water can intrude into the central and southern Delta. Water project operators developed an objective set of water salinity criteria that indicate when the Delta becomes susceptible to salinity intrusion if the DCC is closed and exports are maintained.
- 11 - Fish and water salinity needs are frequently mutually exclusive, with respect to the DCC position, from November through January. Under the situation, if the Data Assessment Team (DAT) and Operations and Fish Forum (OFF) can't resolve the contradiction, they elevate it to the Water Operations Management Team (WOMT).
- 12 - The KL and/or Sac catch index of > 10 from November through February, and > 15 from March through April indicates the "Third Alert". A significant number of juvenile Chinook are in the Delta and potentially exposed to the south Delta exports in the following weeks.
- 13 - FWS conducts a juvenile Chinook Delta survival experiment each year in December and January. The goal is to try to determine the relationship between survival, exports and flow. The objective is 10 consecutive days of consistent environmental parameters, exports and inflow. The criteria to achieve the objective is a KL and/or Sac catch index > 10 , and projected Sacramento River flow increased by 20%.
- 14 - Juvenile Chinook loss at the exports is the only export reduction criteria. The two loss criteria are based on non-clipped Chinook loss density (Figure 8), and Coleman late fall hatchery Chinook cumulative loss. Non-clipped Chinook loss density and hatchery Chinook cumulative loss are the "Fourth and Fifth alerts".
- 15 - Fish Management Agencies (MA) determine whether there is sufficient EWA assets to reduce exports. If there are insufficient EWA assets, the MAs elevate the issue to WOMT for resolution.
- 16 - If EWA assets are sufficient, the MAs reduce exports for a number of days and resume monitoring loss.

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FEB 1993

VI. REASONABLE AND PRUDENT ALTERNATIVE

NMFS is providing the following reasonable and prudent alternative which can be implemented by the Bureau to avoid jeopardy to the Sacramento River winter-run chinook salmon as a result of the proposed long-term operation of the Central Valley Project. This alternative was identified during formal consultation with the Bureau, and in coordination with the California Department of Water Resources, FWS, the California Department of Fish and Game, and the State Water Resources Control Board. This reasonable and prudent alternative includes only actions which were identified during formal consultation and can be implemented in a manner consistent with the intended purpose of the proposed action. If the Bureau implements this reasonable and prudent alternative, NMFS has concluded that the long-term operation of the Central Valley Project is not likely to jeopardize the continued existence of winter-run chinook salmon.

Shasta/Trinity Divisions

1. The Bureau must make its February 15 forecast of deliverable water based on a estimates of precipitation and runoff at least as conservatively as 90 percent probability of exceedance. Subsequent updates of water delivery commitments must be based on at least as conservatively as a 90 percent probability of exceedance forecast.

The use of this more conservative forecasting approach will substantially reduce the risk of adverse temperature conditions occurring in spawning and incubation habitat of the winter-run chinook salmon.

2. The Bureau must maintain a minimum end-of-water-year (September 30) carryover storage in Shasta Reservoir of 1.9 million acre-feet.

A carryover storage of 1.9 million acre-feet in Shasta Reservoir has been judged by the NMFS and the California Department of Fish and Game to be attainable in all but critical and extremely critical water year types (90 percent probability of exceedance). The methodology used for determination of minimum carryover storage needs was an empirical, exploratory type of analysis, based on historic operations, hydrology, and observed and simulated temperatures. This minimum carryover storage level is directed at protecting the critical winter-run chinook salmon spawning reach in a manner consistent with the intended purpose of the Bureau's proposed action.

The NMFS recognizes that it may not be possible to maintain a minimum carryover storage of 1.9 million acre-feet in the driest 10 percent of water year types. If the 90 percent probability of

exceedance runoff forecast projects critical or extremely critical hydrological conditions and the CVP operations forecast projects carryover storage levels in Shasta may drop below 1.9 million acre-feet at the end-of-water-year, the Bureau must reinitiate consultation with NMFS prior to the first water allocations announcement.

The maintenance of 1.9 million acre-feet carryover in Shasta Reservoir will reduce the occurrence of CVP operational cases with low initial reservoir storage conditions to less than 10 percent of water years. This level of carryover storage in Shasta Reservoir improves the Bureau's ability to provide suitable temperature conditions in the upper Sacramento River during the winter-run chinook salmon spawning and incubation period. In combination with the proposed release of cold hypolimnetic water from the low level outlets of Shasta Dam and modification of CVP operations, a minimum carryover storage level in Shasta Reservoir will significantly improve temperature protection in the upper Sacramento River during the winter-run chinook salmon spawning and incubation period.

3. The Bureau must maintain a minimum flow of 3,250 cfs from Keswick Dam to the Sacramento River from October 1 through March 31.

This minimum instream flow is required to provide for safe rearing and downstream passage of winter-run chinook salmon, and to protect against the stranding of juvenile winter-run chinook salmon. NMFS will consider variation from this requirement on a case by case basis when flood conditions threaten human health and safety. In these circumstances NMFS will consider how well accretions from tributary streams will preclude strandings of juvenile fish under the reduced flows.

4. When reductions in releases through Keswick Dam to the Sacramento River are required from July 1 through March 31, the Bureau must reduce flows at night (from sunset to sunrise) as follows:
 - a. For reduction of Keswick Dam releases down to a level of 6,000 cfs, flows must not be decreased more than 15 percent each night. Flows must not be decreased more than 2.5 percent in a one-hour period.
 - b. For reduction of Keswick Dam releases to levels between 5,999 cfs and 4,000 cfs, flows must not be decreased by more than 200 cfs each night. Flows must not be decreased more than 100 cfs in a one-hour period.

- c. For reduction of Keswick Dam releases to levels between 3,999 cfs and 3,250 cfs, flows must not be decreased by more than 100 cfs each night.

During the fall of 1992, these ramping conditions effectively eliminated the adverse effects of flow reductions on juvenile winter-run chinook salmon. NMFS will consider variation from this requirement on a case by case basis when flood conditions threaten human health and safety. In these circumstances, NMFS will consider how well accretions from tributary streams will preclude strandings of juvenile fish under accelerated reductions in flows.

5. The Bureau must maintain daily average water temperature in the Sacramento River at no more than 56°F within the winter-run chinook salmon spawning grounds below Keswick Dam as follows:
 - a. Not in excess of 56°F at Bend Bridge from April 15 through September 30, and not in excess of 60°F at Bend Bridge from October 1 through October 31 for operational environments W-HI, W-HM, W-LM, W-LO, A-HI, A-HM, A-LM, A-LO, and D-HI.
 - b. Not in excess of 56°F at Bend Bridge from April 15 through August 31, not in excess of 56°F at Jelly's Ferry from September 1 through September 30, and not in excess of 60°F at Jelly's Ferry from October 1 through October 31 for operational environment D-HM.
 - c. Not in excess of 56°F at Jelly's Ferry from April 15 through September 30, and not in excess of 60°F at Jelly's Ferry from October 1 through October 31 for operational environments D-LM, D-LO, C-HI, C-HM, C-LM, and E-HI.
 - d. The Bureau must reinitiate consultation 14 days prior to the first announcement of water delivery allocations for operational environments C-LO, E-HM, E-LM, and E-LO.

The February 90-percent exceedance forecast of runoff, or an exceedance forecast at least as conservative, must be used to determine the operational environment and associated temperature compliance points. Any modifications to the February water allocation must comply with the above requirements.

Winter-run chinook eggs and pre-emergent fry require water temperatures at or below 56°F for survival during their spawning and incubation period. Additional modeling efforts by the Bureau in coordination with NMFS and California Department of Fish and

to conduct these activities (i.e., scientific research permit or cooperative agreement).

13. The Bureau and Department of Water Resources in cooperation with the California Department of Water Resources must monitor the extent of incidental take associated with the operation of the Tracy and Byron pumping facilities.

The Bureau and the Department of Water Resources must conduct a monitoring program to determine the extent of incidental taking of winter-run chinook salmon associated with operation of the Tracy and Byron pumping facilities.

Through May 31, 1993, the following monitoring procedures and data analysis must be performed using personnel experienced in salmon biology:

- a. For a minimum period of 10 minutes within each 2 hour interval throughout the day and night (minimum of 120 minutes per day) all salmon are to be measured (fork length to the nearest millimeter), examined for the presence or absence of the adipose fin, and enumerated.
- b. For the period from January 15 through May 31 of 1993 only, a maximum of 150 CWT juvenile winter-run chinook salmon may be taken and sacrificed during the fish counts described above at Tracy and Skinner Fish Collection Facilities combined. CWT winter-run chinook salmon juveniles will have originated from Coleman National Fish Hatchery and will be distinguishable by an adipose fin clip. Each fish sacrificed must be measured, placed in a separate whirl-pak bag, and promptly frozen for transportation to the Stockton office of FWS for CWT recovery. Each sample must be carefully and completely labeled with the following information: (i) sampling location, (ii) date and time, and (iii) fork length in millimeters.

All CWTs from winter-run-size chinook salmon must be promptly recovered and read. A CWT recovery log must be maintained to record the size of each tag (full CWT or half CWT) as it is removed from each fish carcass. In the event CWT readings can not be performed promptly, all half CWT fish shall be considered winter-run chinook salmon until actual tag readings can be performed. Daily and weekly reports must make note if the classification is based solely on CWT size. All carcasses containing half CWTs shall be placed in whirl-pak bags, labeled in the manner described above, and promptly frozen. Frozen samples shall be retained until specific instructions are provided by NMFS.

The Bureau and the California Department of Water Resources are responsible for ensuring the 150 CWT fish limit is not

exceeded. NMFS and FWS will assist in the establishment of a random or stratified sampling scheme when the two facilities combined have collected a total of 100 CWT fish.

- c. With the exception of the CWT fish collected during 1993, all fish are to be processed alive through the established fish salvage process after data has been collected. All mortalities of winter-run-size chinook salmon must be minimized and reported to the Regional Director of NMFS, Southwest Region. All winter-run chinook salmon mortalities shall be placed in whirl-pak bags, labeled in the manner described above, and promptly frozen. Frozen samples shall be retained until specific instructions are provided by NMFS.

- d. Loss estimates are to be determined as follows:

All juvenile chinook salmon that fall within the daily size criteria developed by the California Department of Fish and Game (attachment 1) are to be classified as winter-run chinook salmon.

Winter-run chinook salmon salvage estimates are to be calculated by the following formula:

$$\text{EXP-WR-TTL} = (\text{TTL-WR} \times \text{TTL-PUMP}) / \text{LGT-CNT}$$

EXP-WR-TTL = expanded winter-run chinook salmon salvage

TTL-WR = total winter-run chinook salmon count

TTL-PUMP = total pumping period in minutes

LGT-CNT = length of sampling period in minutes

Winter-run chinook salmon loss estimates are to be calculated by the following formula for the Skinner Fish Collection Facility:

$$\text{TTL-WR-LOSS} = ((\text{EXP-WR-TTL} / 0.75) / 0.25) - (\text{EXP-WR-TTL} \times 0.99)$$

TTL-WR-LOSS = total winter-run chinook salmon loss

EXP-WR-TTL = expanded winter-run chinook salmon salvage

0.75 = average SWP and CVP screen efficiency

0.25 = Skinner pre-screening loss of 75%

0.99 = Handling and trucking loss of 1%

Winter-run chinook salmon loss estimates are to be calculated by the following formula for the Tracy Fish Collection Facility:

$$\text{TTL-WR-LOSS} = (\text{EXP-WR-TTL} / 0.75) / 0.85 - (\text{EXP-WR-TTL} \times 0.99)$$

TTL-WR-LOSS = total winter-run chinook salmon loss
EXP-WR-TTL = expanded winter-run chinook salmon salvage

0.75 = average SWP and CVP screen efficiency
0.85 = Tracy pre-screening loss of 15%
0.99 = Handling and trucking loss of 1%

From October 1, 1992 through May 31, 1993, The Bureau and Department of Water Resources must calculate estimates of winter-run chinook salmon loss (incidental take) on a real-time basis using the methodology described above.

Monitoring program results must be provided to the Regional Director of the NMFS, Southwest Region in accordance with the reporting schedule outlined in term and condition No.13 of the incidental take statement. This monitoring and reporting program will be used by NMFS to monitor the rate of incidental taking and cumulative incidental take, and to determine if there is a need to reinitiate formal consultation.

All monitoring programs that involve the intentional taking of winter-run chinook salmon must be conducted by a person or entity that has been authorized by the National Marine Fisheries Service to conduct these activities (i.e., scientific research permit or cooperative agreement).

VII. REINITIATION OF CONSULTATION

Reinitiation of formal consultation is required if there is discretionary Federal involvement or control over the action and if (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

If CVP operations are modified from those proposed in the CVP-OCAP as modified by the reasonable and prudent alternatives contained in this biological opinion, the Bureau must notify promptly the Regional Director of the NMFS Southwest Region.

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MARCH 31, 2006.

rate, or between approximately 6,000 and 24,000 juveniles each year. However, since most steelhead smolts are 200 to 250 mm in length at the time of salvage, the loss rate is expected to be at the lower end of the range, because steelhead are larger than Chinook salmon juveniles; therefore, steelhead survival is higher through the Delta export pumps.

NOAA Fisheries anticipates that take of juvenile CV spring-run Chinook salmon will remain approximately the same as that considered in the 2002 SR/S OCAP opinion, but for CV steelhead will increase from what was previously considered, due to changes in upstream CVP operations on the American River and issuance of interim contracts on the Feather River Unit. NOAA Fisheries estimates that approximately 6 percent of the annual juvenile steelhead production will be killed on the American River due to flow changes to meet water quality standards in the Delta. On the Feather River, approximately 200 to 600 juvenile Chinook salmon (all races combined) and 50 to 100 steelhead will be killed each year through entrainment into an unscreened diversion. Based on recent information, an average of 100 adult steelhead (> 350 mm) may be salvaged each year at the CVP and SWP Delta fish collection facilities.

Reclamation and DWR have proposed to operate CVP and SWP facilities in accordance with either plans, agreements, or specific criteria outlined in this biological opinion. Deviations from these plans, agreements, or criteria may result in adverse impacts to CV spring-run Chinook salmon and CV steelhead that have not been analyzed in this opinion. In this event, formal consultation shall be reinitiated immediately to analyze the effects to spring-run Chinook salmon and steelhead and determine if the changes are likely to jeopardize these species or result in additional incidental take.

B. Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of essential habitat.

C. Reasonable and Prudent Measures

NOAA Fisheries has added one additional reasonable and prudent measure (No. 8 [in brackets]) to the incidental take statement of the 2002 SR/S OCAP opinion, which we believe is necessary and appropriate to minimize take of CV steelhead and CV spring-run Chinook salmon. New language is underlined, in **bold type**, and *italicized*:

NOAA Fisheries believes the following reasonable and prudent measures are necessary and appropriate to minimize take of CV steelhead and CV spring-run Chinook salmon:

1. Reclamation and DWR shall minimize the adverse effects of flow fluctuations associated with upstream reservoir operations on the incubating eggs, fry, and juvenile steelhead and spring-run Chinook salmon.

2. Reclamation and DWR shall gather information regarding the effects of flow fluctuations on spring-run Chinook salmon and steelhead downstream of CVP and SWP reservoirs, develop long-term ramping criteria, and operate to the extent possible to meet temperature objectives that will avoid or minimize adverse effects.
3. Reclamation and DWR shall operate to temperature objectives to the extent possible below Project Dams that will avoid or minimize adverse effects to spring-run Chinook salmon and steelhead.
4. Reclamation shall minimize the adverse effects of Delta Cross Channel gate operations on juvenile steelhead and spring-run Chinook salmon.
5. Reclamation and DWR shall minimize the adverse effects of Delta exports on juvenile steelhead and spring-run Chinook salmon.
6. Reclamation and DWR shall collect additional data at the fish salvage collection facilities for improving facility operations and incidental take monitoring with regard to steelhead and spring-run Chinook salmon.
7. Reclamation in coordination with DWR shall submit weekly Data Analysis Team (DAT) reports and annual written reports to NOAA Fisheries regarding the results of monitoring and incidental take of spring-run Chinook salmon and steelhead associated with operations of Project facilities (50 CFR 402.14[I][3]).

[8. Reclamation and DWR shall work with NOAA Fisheries staff to minimize take from unscreened diversions that are a part of interim water contract renewals.]

D. Terms and Conditions

NOAA Fisheries has changed two terms and conditions (Nos. 5.b. and 5.d. [in brackets]) and added two terms and conditions (Nos. 6.d. and 8.a. [in brackets]) to the incidental take statement of the 2002 SR/S OCAP opinion, to implement the reasonable and prudent measures and minimize take of CV spring-run Chinook salmon and CV steelhead. These changes and additions in part reflect the availability of new information on sources of Project incidental take and the CV steelhead population trend (NOAA Fisheries 2003), as well as the changes and two-year extension to Project operations. New language is underlined, in **bold type**, and *italicized*:

Reclamation and DWR must comply or ensure compliance by their contractor(s) with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. Reclamation and DWR shall minimize the adverse effects of flow fluctuations associated with upstream reservoir operations on the incubating eggs, fry, and juvenile steelhead and spring-run Chinook salmon.

- a. Reclamation and DWR shall coordinate with NOAA Fisheries before reducing releases downstream of Keswick Dam, Whiskeytown Dam, Nimbus Dam, Oroville Dam, and/or Goodwin Dam to a monthly average flow less than the levels identified in the CVPIA b(2) forecast or the AFRP revised flow matrix.
- b. Clear Creek-Reclamation shall assist in developing a Fisheries Management Plan (FMP) in coordination with DFG, FWS and NOAA Fisheries that will balance upstream flow and temperature requirements of spring-run Chinook salmon, steelhead and fall-run Chinook salmon with the impact of operations on other CVP objectives, including water supply, power, and temperature control for winter-run Chinook salmon.
- c. Feather River-During periods outside of flood control operations and to the extent controllable during flood control operations, DWR shall ramp down releases to the low flow channel as presented in the table below:

Feather River Low-Flow Channel Releases (cfs)	Rate of Decrease (cfs)
5,000 to 3,501	1,000 per 24 hours
3,500 to 2,501	500 per 24 hours
2,500 to 600	200 per 24 hours

- d. American River - During periods outside of flood control operations and to the extent controllable during flood control operations, Reclamation shall ramp down releases in the American River below Nimbus Dam as presented in the tables below. From January 1 through March 31, Reclamation must insure fisheries monitoring is conducted during ramp down of stream flows below 1500 cfs to minimize dewatering of steelhead redds or adverse effects to incubating eggs. During any 24-hour period, Reclamation must not decrease the river release from Nimbus more than the range in each row of the table. To the extent possible, Reclamation must make at least three separate equal release changes during each 24-hour period and separate the changes by equal time periods. Below 5,000 cfs, Reclamation must not reduce more than 500 cfs during any 24-hour period, or decrease flows more than 50 cfs per hour. For reductions below 1,500 cfs, Reclamation must coordinate with NOAA Fisheries (or DFG and/or FWS if NOAA Fisheries is not available).

Lower American River Daily Rate of Change (cfs)	Amount of Decrease in 24 hrs (cfs)
20,000 to 16,000	4,000
16,000 to 13,000	3,000
13,000 to 11,000	2,000
11,000 to 9,500	1,500
9,500 to 8,300	1,200
8,300 to 7,300	1,000
7,300 to 6,400	900
6,400 to 5,650	750
5,650 to 5,000	650

The following table gives the individual desired flow rates for the lower American River (3 changes per day) in more detail.

Initial Flow 20,000 (cfs)	First Flow Change (cfs)	Second Flow Change (cfs)	Third Flow Change (cfs)
Day 1	18,650	17,300	16,000
Day 2	15,000	14,000	13,000
Day 3	12,300	11,600	11,000
Day 4	10,500	10,000	9,500
Day 5	9,100	8,700	8,300
Day 6	7,950	7,600	7,300
Day 7	7,000	6,700	6,400
Day 8	6,150	5,900	5,650
Day 9	5,400	5,200	5,000

- e. Stanislaus River - During periods outside of flood control operations and to the extent controllable during flood control operations, Reclamation shall ramp down

releases in the Stanislaus River below Goodwin Dam as presented in the table below:

Existing Release Level (cfs)	Rate of Increase (cfs)	Rate of Decrease (cfs)
at or above 4,500	500 per 4 hours	500 per 4 hours
2,000 to 4,499	500 per 2 hours	500 per 4 hours
500 to 1,999	250 per 2 hours	200 per 4 hours
300 to 499	100 per 2 hours	100 per 4 hours
150 to 299	75 per 2 hours	50 per 4 hours

2. Reclamation and DWR shall gather information regarding the effects of flow fluctuations on spring-run Chinook salmon and steelhead downstream of CVP and SWP reservoirs, develop long-term ramping criteria, and operate to temperature objectives that will avoid or minimize adverse effects.
 - a. Reclamation and DWR shall participate in the design and implementation of a monitoring program for CV steelhead and CV spring-run Chinook salmon that will include adult and juvenile direct counts, redd surveys, and escapement estimates on CVP and SWP controlled streams during 2002 through 2004. The program shall include identification and evaluation of steelhead and spring-run Chinook salmon rearing and spawning habitat along with areas of potential stranding and isolation. This information shall serve as a basis for establishing long-term ramping rate criteria and temperature compliance points. The monitoring proposal and schedule for implementation must be submitted to NOAA Fisheries for review and approval by November 30, 2002. If appropriate, authorization for any incidental take associated with the implementation of these monitoring programs will be provided to Reclamation, DWR, or their agent, after NOAA Fisheries review and approval of the study plans.
 - b. All monitoring programs that involve the intentional taking of spring-run Chinook salmon or steelhead must be conducted by a person or entity that has been authorized by NOAA Fisheries. Reclamation will establish a contact person for these activities.
 - c. Stanislaus River-Reclamation shall provide an annual report regarding results of the 2002-2004 fisheries monitoring studies to the following address by September 30 of each year:

Supervisor, Sacramento Area Office
NOAA Fisheries
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

The report shall include: (1) the number of steelhead captured; (2) fork length; (3) condition (*e.g.*, alive, injured, dead, and life stage characterization); (4) number of steelhead released back into the river; and (5) other information collected (*e.g.*, water velocity, temperature, and turbidity measurements). Life stage characterization guidelines are available in the Steelhead Life-Stage Assessment Protocol developed by the IEP Steelhead Project Work Team (December 1998).

- d. At least one trained and qualified fisheries technician (*i.e.*, minimum of 2 years experience with sampling and handling of juvenile anadromous salmonids) shall be onsite during each day of sampling throughout the duration of the fisheries monitoring program to insure full adherence to the sampling and handling protocols identified in the Stanislaus River Sampling Plan submitted by Reclamation to NOAA Fisheries on May 14, 1999.
- e. Incidental take of juvenile steelhead in the Stanislaus River by rotary screw traps may not exceed 60 steelhead smolts in one sampling season.
- f. Incidental take associated the CALFED funded resistance board weir for adult Chinook salmon escapement may not exceed 100 adult steelhead (with 5 percent mortality) and 50 tissue samples (scales, fin clips or Deoxyribonucleic acid [DNA] samples) for the year.
- g. Feather River - DWR shall provide a written report containing the results of rotary screw traps, fyke traps, snorkel surveys, creel census and tissue sampling for 1999 through 2002 monitoring studies to:

Supervisor, Sacramento Area Office
NOAA Fisheries
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

In addition, DWR will continue with the stranding and isolation study as proposed in its August 7, 2000, report to NOAA Fisheries. Additional studies are needed to determine: 1) in-river abundance, 2) spawning habitat utilization, and 3) suitability of current flow pattern (600 cfs) for all life-stages of CV spring-run Chinook salmon and CV steelhead. Incidental take associated with Feather River monitoring studies may not exceed the following:

spring-run size Chinook salmon (YOY): 3,000
spring-run size Chinook salmon (juveniles): 10
steelhead juveniles : 600
steelhead adults: 25

- h. At least one trained and qualified Fisheries technician (*i.e.*, minimum of 2 years experience with sampling and handling of juvenile anadromous salmonids) shall be onsite during each day of sampling throughout the duration of the Fisheries monitoring program to insure full adherence to the sampling and handling protocols identified in the Stranding and Redd De-watering Study Plan submitted by DWR on August 7, 2000.
- 3. Reclamation and DWR shall operate to temperature objectives, to the extent possible, below Project dams that will avoid or minimize adverse effects to spring-run Chinook salmon and steelhead. Reclamation shall work with the Sacramento River Temperature Task Group and the American River Workgroup to ensure compliance with other obligations of the Project. NOAA Fisheries will not consider reinitiating of consultation necessary if the temperature objective is exceeded by 0.5 °F or less provided the Bureau or DWR has promptly implemented measures to reduce the temperature to the objective and the exceedence lasts no more than 3 days. Reclamation and DWR must provide written notification to NOAA Fisheries after 3 days of temperature exceedence.
 - a. Clear Creek - In the absence of a FMP, Reclamation shall, to the extent possible, control water temperatures by flow releases from Whiskeytown Dam to the Igo gage between June 1 through September 15, to a daily average temperature of 60 °F, to protect over-summering juvenile steelhead from thermal stress and from warm water predators. In addition, from September 15 through October 30, Reclamation shall reduce water temperatures to 56 °F to protect spring-run Chinook salmon spawning and egg incubation.
 - b. American River - Reclamation shall, to the extent possible, control water temperatures in the lower river between Nimbus Dam and the Watt Avenue Bridge (River Mile [RM] 9.4) from June 1 through November 30, to a daily average temperature of less than or equal to 65 °F to protect rearing juvenile steelhead from thermal stress and from warm water predator species. The use of the cold water pool in Folsom Reservoir should be reserved for August through October releases.
 - c. Stanislaus River - Reclamation shall, to the extent possible, control water temperatures by flow releases to the lower river between Goodwin Dam (RM 58.5) and Orange Blossom Road bridge (USGS gage) during June 1 through November 30, to a daily average temperature of less than or equal to 65 °F to protect over-summering steelhead from thermal stress and from warm water

predator species. If temperature releases are required, Reclamation must coordinate with DFG and FWS to use fishery release water consistent with NMIP, D-1641, and CVPIA.

- d. Feather River-DWR shall, to the extent possible and consistent with SWP requirements, control water temperatures between the Fish Barrier Dam and RM 61.6 (Robinsons Riffle) from June 1 through September 30 to a daily average temperature of less than or equal to 65 °F to protect over-summering steelhead from thermal stress and from warm water predator species. This term is not intended to preclude pump-back operations at the Oroville Complex that are needed to assist the State of California with supplying energy during periods when the California Independent Service Operator has anticipated Stage 2 or higher alerts.
4. Reclamation shall minimize the adverse effects of DCC gate operations on juvenile steelhead and spring-run Chinook salmon.
 - a. During the period from April 1, 2004, through March 31, 2006, Reclamation shall operate the gates of the DCC consistent with the CALFED OPS (*i.e.*, stakeholder water operations group), Water Quality Control Plan D-1641 and the *Provisional Fall/Winter Juvenile Salmon Decision Process (October 1-March 31)*. Reclamation and NOAA Fisheries, in coordination with the DAT will monitor water quality conditions within the Delta. Gate openings for water quality improvements shall be coordinated with NOAA Fisheries (Sacramento Area Office), DFG, and FWS and openings shall be minimized if fisheries monitoring results indicate juvenile Chinook salmon and steelhead are emigrating in the vicinity of the DCC.
 - b. To address the potential competing objectives of water quality improvement and fisheries protection, Reclamation and DWR shall develop specific water quality criteria, operational rules, and decision making process for operation of the DCC gates during the period between October 1 and March 31. This effort shall include investigation of whether hydrodynamic models can be used to predict potential water quality problems and alternative operations scenarios for the DCC gates and the Delta export pumps. Updated water quality criteria, operational rules, and the decision-making process shall be provided to NOAA Fisheries for review and concurrence as revisions occur.
 5. Reclamation and DWR shall minimize the adverse effects of Delta exports on juvenile steelhead and spring-run Chinook salmon.
 - a. Based on observations of juvenile steelhead, juvenile spring-run size Chinook salmon (70 mm to 150 mm), or late-fall Chinook salmon surrogates (CWT fish

from Coleman NFH) in: 1) lower Sacramento River Fisheries monitoring stations (Knights Landing, Sacramento Trawl, beach seine program); 2) Delta Fisheries monitoring stations (beach seine program, Chipps Island); or 3) Tracy or Skinner fish salvage facilities; Reclamation and DWR shall reduce CVP and SWP pumping levels to improve the survival of steelhead and spring-run Chinook smolts in the Delta for periods extending from five to ten days. These export reductions to a combined CVP/SWP pumping rate of 4,000 to 10,000 cfs, depending on Delta inflow conditions, will be implemented based on the protocol and water quality criteria established in the *Salmon Decision Process* and initiated by NOAA Fisheries. The decision to implement these export curtailments, their duration, and specific export level will be made by Reclamation and DWR. This decision will be based on discussions within the WOMT after receiving recommendations from the DAT. NOAA Fisheries will provide Reclamation and DWR, at minimum, 72 hours notice prior to the initiation of the target CVP/SWP export rates. NOAA Fisheries will make every effort possible to ensure that recommendations combine these export curtailments with the currently proposed (b)(2) actions FWS. Curtailments pursuant to this term and condition are not constrained by the Department of Interior's (b)(2) water budget.

- [b. Incidental take of yearling spring-run Chinook salmon at the CVP and SWP Delta export facilities will be based on observations of CWT late-fall Chinook salmon uniquely marked at Coleman NFH and released in the upper Sacramento Basin. Loss at the CVP and SWP Delta export facilities may not exceed one percent of any surrogate release group (determined by NOAA Fisheries and the CALFED DAT each year before November) of CWT late fall Chinook salmon released in the upper Sacramento Basin from April 1, 2002, through March 31, 2004. Take will be calculated with the standard loss estimation procedures applicable at the respective fish collection facilities. At the one percent cumulative loss level, Reclamation and DWR must take actions to avoid further loss and reinitiate consultation.]
- c. Incidental take of YOY spring-run Chinook salmon from December to May shall be determined using mixed stock analysis of CWT recoveries at the Delta Fish Facilities and applied to the adult escapement estimates for each drainage. Therefore, the estimated YOY spring-run Chinook salmon loss may not exceed one percent of the total YOY Chinook salmon loss at the Delta Fish Facilities in any one year.
- [d. Incidental take of steelhead at the CVP (Tracy) and SWP (Skinner) export facilities will be based on seasonal yearly observations of unmarked steelhead at the Tracy and Skinner fish collection facilities from October through September. Combined cumulative salvage of juvenile and adult unmarked steelhead at the

CVP and SWP export facilities may not exceed 3,500 fish during this period, based on the salvage estimation procedures described in the Four Pumps Agreement at the respective collection facilities. If cumulative salvage of unmarked steelhead reaches 3,500 fish for the water year (October through September), Reclamation and DWR must take actions to avoid further collection and salvage of steelhead and reinitiate consultation.]

- e. Incidental take for the Rock Slough Old River Intake will be based on current DFG monitoring until a fully screened intake is built. Loss of juvenile spring-run Chinook salmon and steelhead shall be combined with Tracy and Banks fish facilities and reported in an annual monitoring report (see 7 [a]).
 - f. Incidental take for the Suisun Marsh Salinity Control Gates shall be based upon DFG monitoring studies associated with gate operations. It is anticipated that some adult steelhead may be caught during these studies, therefore up to 10 adult steelhead may be tagged to determine their migratory patterns.
6. Reclamation and DWR shall collect additional data at the fish salvage collection facilities for improving facility operations and incidental take monitoring with regard to steelhead and spring-run Chinook salmon.
- a. DNA tissue samples and CWT samples from juvenile spring-run Chinook salmon and steelhead at the Tracy and Skinner fish collection facilities shall be collected by DWR or DFG for genetic analysis or tag removal/reading pursuant to the sampling protocols established by the IEP Salmon Genetics Project Work Team. Tissues shall be stored at the DFG tissue bank at Rancho Cordova for subsequent analysis by Oregon State University or similar lab approved by NOAA Fisheries. Whole fish or heads for CWT processing/identification shall be stored at the FWS Bay/Delta Office in Stockton. All samples shall be clearly marked according to office protocol and a log maintained at each storage facility. Unclipped steelhead samples for DFG otolith studies may be collected and stored at the above facilities after providing NOAA Fisheries, Sacramento Office with a detailed study plan.
 - b. For the period from October 1 through June 30, Reclamation and DWR must calculate a daily loss estimate for juvenile steelhead through the Tracy and Skinner Fish Facilities, which includes predation through Clifton Court (*i.e.*, prescreen loss), louver efficiencies, and trucking and handling loss, on a real-time basis similar to how Chinook salmon loss is calculated.
 - c. Reclamation and DWR must use personnel for monitoring at the fish salvage facilities that are experienced in the sampling and handling of juvenile anadromous salmonids. This experience should include instruction in at least one course in juvenile fish identification that includes both salmon and steelhead.

[d. Reclamation shall implement the expanded fish monitoring plan developed by the California Department of Fish and Game for the Rock Slough pumping plant and Contra Costa Canal by May 1, 2004. This monitoring effort shall include yearly CV spring-run Chinook salmon and CV steelhead loss estimates.]

7. Reclamation in coordination with DWR shall submit weekly DAT reports and annual written reports to NOAA Fisheries regarding the results of monitoring and incidental take of spring-run Chinook salmon and steelhead associated with operations of Project facilities (50 CFR 402.14[I][3]).

a. Reclamation in coordination with DWR shall provide a written annual data report to be submitted by September 30 of each year. This report shall summarize the results of CV spring-run Chinook salmon and CV steelhead monitoring and incidental take associated with the operation of the Delta Fish Facilities (including the Rock Slough Pumping Plant). All juvenile mortality must be minimized and reported, including those from special studies conducted during salvage operations. This report should be sent to:

Supervisor, Sacramento Area Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

[8. Reclamation and DWR shall work with NOAA Fisheries staff to minimize take from unscreened diversions that are a part of interim water contract renewals.

a. Reclamation and DWR shall work with NOAA Fisheries engineers to assist Feather Water District in the design of a fish screen for the diversion located on the Feather River. This fish screen must be in place and fully functional by February 1, 2005, or one year from issuance of this opinion.]

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These "conservation recommendations" include discretionary measures that Reclamation and DWR can take to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of information. In addition to the terms and conditions of the Incidental Take Statement, the NOAA Fisheries provides the following conservation recommendations that would reduce or avoid adverse impacts on the listed species:

"FOUR PUMPS AGREEMENT"

APPENDIX A

PART I ESTIMATION OF THE FIVE YEAR AVERAGE OF YEARLING EQUIVALENT LOSS OF STRIPED BASS (LARGER THAN 20 MM), CHINOOK SALMON, AND STEELHEAD LOST DURING FISH SALVAGE OPERATIONS AT THE INTAKE TO THE CALIFORNIA AQUEDUCT

GENERAL APPROACH

The number of fish lost at the intake to the State Water Project (SWP) export system is calculated from the estimated number of fish salvaged (collected) at the fish facility adjusted by factors affecting their survival. The number of fish salvaged during the first and second half of a month is estimated from a sampling program at the facility. The sampling program is based on fish counts made at fairly regular intervals during the day. Salvage is stratified by size group.

Losses occur both before and after fish are collected in the holding tanks where they are counted. Losses are estimated from the time fish are entrained into the forebay until they are transported and released back into the Delta. Fish entrained into the forebay are lost in two ways before they are collected in the facility; (i) predation loss (P) in the forebay, (ii) loss through the fish screens. After fish have been collected, some fish die as a result of the handling (H) and trucking (T) required to return them to the Delta.

Losses of fish are standardized to yearling equivalents by estimating the number which would have survived to that age.

Survival of striped bass to the yearling stage is a function of the growth and mortality rates of the various length groups the fish must live through to become yearlings. It is also a function of the time of year during which a given size fish is collected.

Instantaneous growth rates (G) and mortality rates (Z) for each length group were calculated from equations developed by Miller (ms):

$$\ln(Z) = -1.10957 - 0.04236 \times FL \text{ mm}$$

$$\ln(G) = -2.78628 - 0.03245 \times FL \text{ mm}$$

Daily growth was estimated at the mid-point of each length interval by the following equation, where $(t_2 - t_1) = 1$ day:

$$L(t+1) = L(t) \times e^{G(t_2 - t_1)}$$

The daily growth rate for each length group (i) was then calculated as the mean of the daily growth rates at the mid-points of length groups (i) and (i+1).

These relationships may be modified as additional information on mortality and growth become available. This data was used to calculate the survival rate for each length group and the number of days a fish spends in the group (Table 1). Yearling equivalent survival factors for striped bass are then calculated as the product of the individual survival rates for each length interval that a fish must live through to become a yearling (Table 2). Yearling status for the purposes of this model is defined as living to the first half of March or reaching the 141-150 mm length interval.

TABLE 1. STRIPED BASS SURVIVAL RATES FOR VARIOUS LENGTH GROUPS AND THE NUMBER OF DAYS SPENT IN EACH GROUP

Species	Length Interval (mm)	Survival ^{1/} Rate	Number days in length Interval
STRIPED BASS	21 - 25	0.4082	7.2
	26 - 30	0.4892	7.1
	31 - 35	0.5562	7.2
	36 - 40	0.5005	10.5
	41 - 50	0.4477	16.4
	51 - 60	0.5453	18.9
	61 - 70	0.6247	22.4
	71 - 80	0.6898	27.0
	81 - 90	0.7416	33.2
	91 - 100	0.7835	41.4
	101 - 110	0.8182	52.0
	111 - 120	0.8467	65.9
	121 - 130	0.8701	84.1
	131 - 140	0.8896	108.0
	141 - 150	0.9058	139.5
	≥ 151		

^{1/} Survival rates refer to survival from the mid-point of the length interval to the mid-point of the subsequent interval.

TABLE 2. STRIPED BASS YEARLING EQUIVALENT SURVIVAL FACTORS STRATIFIED BY SIZE GROUP AND TIME OF YEAR ENTRAINED INTO THE STATE WATER PROJECT.

Semi-Monthly Period		21-25 mm	26-30 mm	31-35 mm	36-40 mm	41-50 mm
JAN	1	0.017741	0.034535	0.060131	0.092805	0.150022
	2	0.030892	0.055883	0.090934	0.129617	0.203513
FEB	3	0.072347	0.116592	0.168253	0.216577	0.308627
	4	0.205760	0.278857	0.355389	0.421823	0.503530
MAR	5	0.002157	0.005229	0.010560	0.018725	1
	6	0.002211	0.005360	0.010825	0.019195	1
APR	7	0.002270	0.005504	0.011115	0.019710	0.038623
	8	0.002327	0.005642	0.011394	0.020205	0.039593
MAY	9	0.002397	0.005784	0.011681	0.020713	0.040588
	10	0.002489	0.005996	0.012035	0.021233	0.041607
JUN	11	0.002592	0.006244	0.012531	0.022083	0.042878
	12	0.002692	0.006485	0.013015	0.022935	0.044534
JUL	13	0.002797	0.006735	0.013518	0.023821	0.046254
	14	0.002963	0.007070	0.014056	0.024741	0.048040
AUG	15	0.003152	0.007521	0.014952	0.026097	0.050022
	16	0.003340	0.007969	0.015843	0.027652	0.052950
SEP	17	0.003627	0.008528	0.016852	0.029414	0.056322
	18	0.003962	0.009316	0.018256	0.031403	0.059678
OCT	19	0.004328	0.010177	0.019944	0.034306	0.064306
	20	0.004936	0.011350	0.021787	0.037477	0.070250
NOV	21	0.005701	0.013108	0.025126	0.042267	0.077197
	22	0.006895	0.015319	0.028759	0.048378	0.087780
DEC	23	0.008475	0.018829	0.034896	0.056735	0.100472
	24	0.011576	0.024409	0.042968	0.069733	0.120391

TABLE 2. Continued.

Semi-Monthly Period		51-60 mm	61-70 mm	71-80 mm	81-90 mm	91-100 mm
JAN	1	0.267298	0.395377	0.517053	0.636937	0.732085
	2	0.328535	0.464298	0.591813	0.695812	0.775713
FEB	3	0.450597	0.578569	0.683500	0.777180	0.847867
	4	0.638145	0.745224	0.824871	0.881578	0.920797
MAR	5	1	1	1	1	1
	6	1	1	1	1	1
APR	7	1	1	1	1	1
	8	1	1	1	1	1
MAY	9	0.088168	1	1	1	1
	10	0.090383	1	1	1	1
JUN	11	0.092807	0.164786	0.253976	1	1
	12	0.095369	0.168926	0.260356	1	1
JUL	13	0.099052	0.173169	0.266896	0.370199	1
	14	0.102877	0.179686	0.273601	0.379499	1
AUG	15	0.107120	0.187097	0.282796	0.389676	0.497496
	16	0.111257	0.194322	0.293717	0.399465	0.509993
SEP	17	0.118007	0.202337	0.305831	0.414317	0.523670
	18	0.125039	0.212971	0.317641	0.430317	0.536824
OCT	19	0.132491	0.225663	0.331074	0.446934	0.554296
	20	0.142362	0.239111	0.350803	0.464193	0.575701
NOV	21	0.156441	0.256420	0.373146	0.487611	0.599445
	22	0.170902	0.280122	0.395383	0.516669	0.622594
DEC	23	0.193498	0.306016	0.428994	0.547459	0.649542
	24	0.221476	0.342336	0.468648	0.580084	0.688251

TABLE 2. Continued.

Semi-Monthly Period		101-110 mm	111-120 mm	121-130 mm	131-140 mm	141-150 mm
JAN	1	0.803845	0.861540	0.907024	0.938102	0.959032
	2	0.843837	0.894810	0.929809	0.953466	0.969286
FEB	3	0.897581	0.931715	0.954744	0.970131	0.980344
	4	0.947408	0.965254	0.977110	0.984952	0.990123
MAR	5	1	1	1	1	1
	6	1	1	1	1	1
APR	7	1	1	1	1	1
	8	1	1	1	1	1
MAY	9	1	1	1	1	1
	10	1	1	1	1	1
JUN	11	1	1	1	1	1
	12	1	1	1	1	1
JUL	13	1	1	1	1	1
	14	1	1	1	1	1
AUG	15	0.596247	1	1	1	1
	16	0.607762	1	1	1	1
SEP	17	0.624061	0.712355	0.783436	1	1
	18	0.639737	0.724022	0.796267	1	1
OCT	19	0.655808	0.735879	0.809308	0.862891	0.905856
	20	0.672282	0.753957	0.822562	0.872116	0.908079
NOV	21	0.690310	0.774176	0.836940	0.882066	0.918439
	22	0.715664	0.793623	0.850647	0.892512	0.928259
DEC	23	0.743301	0.813559	0.864579	0.907130	0.938183
	24	0.772005	0.833996	0.883336	0.921986	0.948214

The Yearling Equivalent Survival Factor (YESF) for young-of-the-year (YOY) chinook salmon (1-100 mm) is defined as the ratio of the ocean contribution rate of YOY salmon reaching the Delta (0.96%) to the ocean contribution rate of yearling salmon (>100 mm) not impacted by Delta pumping (3.0%):

$$0.96 / 3.0 = 0.32$$

The above ocean contribution rate of 0.96% was developed by Hallock (1979) for hatchery smolt-sized (YOY) chinook salmon from the Sacramento River system. The ocean contribution rate of 3.0% is based on ocean recoveries of coded wire tagged yearling fall run chinook salmon reared at the Feather River and Mokelumne River hatcheries and released at Rio Vista and Vallejo.

The Yearling Equivalent Survival Factor (YESF) for yearling chinook salmon (>100 mm) is defined as 1.0.

Adequate information is not available for steelhead, therefore, chinook salmon data is used to estimate the YESF. The YESF for YOY steelhead (1-100 mm) is defined as the ratio of the ocean contribution rate of YOY salmon reaching the Delta (0.96%) to the ocean contribution rate of yearling salmon (>100 mm) impacted by Delta pumping (1.1%):

$$0.96 / 1.1 = 0.8727$$

The above ocean contribution rate of 1.1% is based on ocean recoveries of coded wire tagged yearling fall run chinook salmon reared at the Merced River Hatchery and released in the Merced River.

The Yearling Equivalent Survival Factor (YESF) for yearling steelhead (>100 mm) is defined as 1.0.

<u>Species</u>	<u>Length Interval (mm)</u>	<u>Survival Rate</u>
CHINOOK	1 - 100	0.32
SALMON	≥ 101	1.0000
STEELHEAD	1 - 100	0.8727
	≥ 101	1.0000

ESTIMATION PROCESS

Loss estimates are generated for each time interval, species, and size group. These are summed over time to estimate semi-monthly and annual losses. Each year's replacement obligation is the average of the annual loss estimates for the previous five years.

EFFICIENCY OF FISH SCREENS

Parameters used to calculate screening loss are influenced by the size of the fish and the velocity of water passing through the fish screens. Regression equations predicting screening efficiencies for different length intervals of fish, based on primary water velocity (fps), were developed from data collected during a field testing program at the fish facility in 1970-71:

Striped Bass

Length Interval (mm)

- A) 21 - 30
- B) 31 - 40
- C) ≥ 41

$$\begin{aligned}\text{Eff(A)} &= 0.935 - (0.149 \times \text{Velocity}) \\ \text{Eff(B)} &= 0.806 - (0.0431 \times \text{Velocity}) \\ \text{Eff(C)} &= 0.945 - (0.0717 \times \text{Velocity})\end{aligned}$$

Chinook Salmon and Steelhead

Length Interval (mm)

- A) 1 - 100
- B) ≥ 101

$$\begin{aligned}\text{Eff(A)} &= 0.630 + (0.0494 \times \text{Velocity}) \\ \text{Eff(B)} &= 0.568 + (0.0579 \times \text{Velocity})\end{aligned}$$

NUMBER OF FISH ENCOUNTERING FISH SCREENS

The number of fish encountering the screens after crossing the forebay is calculated by dividing the number of fish salvaged by the screening efficiency (Eff):

$$\# \text{Encountering Screens} = \# \text{Salvaged} / \text{Eff}$$